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TITTABAWASSEE RIVER  
SEGMENTS 6 AND 7 BANK MANAGEMENT AREA (BMA)  
MEMORANDUM



Prepared by:  
**Tittabawassee and Saginaw River Team**

Prepared for and Submitted by:  
**The Dow Chemical Company**

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## Acronyms and Abbreviations

%	percent
AOC	Administrative Settlement Agreement and Order on Consent
BMA	bank management area
DEQ	Michigan Department of Environmental Quality
Dow	The Dow Chemical Company
ft	foot/feet
PCOI	primary constituent of interest
Site	Tittabawassee River/Saginaw River & Bay Site
SOW	statement of work
TEQ	toxic equivalency
USEPA	US Environmental Protection Agency

# 1 Introduction

The Administrative Settlement Agreement and Order on Consent (AOC) for the Tittabawassee River/Saginaw River & Bay Site (Site) (Settlement Agreement No. V-W-10-C-942) and associated Statement of Work (SOW; Attachment A of AOC), effective January 21, 2010, set forth requirements for conducting evaluations of current conditions and assessments of response options to protect human health and the environment at the Site. Consistent with the requirements of the SOW the Dow Chemical Company (Dow) prepared the Segments 6 and 7 Response Proposal, which was submitted to the United States Environmental Protection Agency (USEPA) in consultation with the Michigan Department of Environmental Quality (DEQ; collectively the Agencies) on May 31, 2016 (Dow 2018).

In the Segments 6 and 7 Response Proposal, the banks in Segments 6 and 7 were assessed as a potential source of primary constituents of interest (PCOIs) based on those characteristics that could potentially result in migration of contaminated soils to the sediment surface in the river. Bank soil with elevated toxic equivalency (TEQ) with the potential to migrate into the river channel is a basis to designate a stretch of bank as a bank management area (BMA). In the Segments 6 and 7 Response Proposal, Segment 6 and 7 BMAs were identified based on a multiple characteristic evaluation of the bank properties. The evaluation incorporated anthropomorphic changes to the banks, geomorphological features, a multiline-of-evidence evaluation on bank stability, and delineation of relative bank TEQ levels.

As a result of the Segments 6 and 7 bank evaluation presented in the Segments 6 and 7 Response Proposal, five bank areas were characterized as low stability banks<sup>1</sup> with a high TEQ index<sup>2</sup> and carried forward as Segments 6 and 7 BMAs. These areas are identified by purple dashed boxes in Figures 1 and 2, similar to Figures 3-31A and 3-31B in the Segments 6 and 7 Response Proposal. As discussed in the Segments 6 and 7 Response Proposal, Dow, working with the Agencies, would further evaluate intermediate TEQ index banks in low stability areas to determine if these banks warrant a response action. The purpose of this memorandum is to summarize the results of these Segments 6 and 7 bank area evaluations and determine if they should be carried forward as Segments 6 and 7 BMAs.

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<sup>1</sup> Bank stability was evaluated using five lines of evidence that incorporate empirical and model-based information, as outlined in the Segments 6 & 7 Response Proposal. To be characterized as a high/moderate stability bank, at least four of the five high/moderate stability criteria must be met; otherwise, banks were characterized as low stability.

<sup>2</sup> The TEQ index is calculated by multiplying the bank core length weighted average TEQ by the bank height. Following the calculation of a relative TEQ index for banks in Segments 2 through 7, the banks were ordered from highest to lowest TEQ index. Banks with the highest TEQ indices that contain 50% of the total bank TEQ index (a TEQ index range of 0-50%), were identified as high TEQ index banks. Banks with a TEQ index range of 50-75% were identified as intermediate TEQ index banks.

## 2 Evaluation of Segments 6 and 7 Banks

In the Segments 6 and 7 Response Proposal, 0.3 miles and 0.1 miles of Segment 6 and Segment 7 banks, respectively, were characterized as intermediate TEQ index in low stability areas. These areas are identified by the yellow boxes in Figure 1 and 2, and are listed below.

Segment 6:

- Area A: Northeast side of Reach NN/OO
- Area B: Southwest side of Reach OO
- Area C: Southwest side of Reach PP
- Area D: Northeast side of Reach RR
- Area E: Northeast side of Reach RR

Segment 7:

- Area F: Northeast side of Reach UU, adjacent to BMA 7-1
- Area G: Northeast side of Reach VV, adjacent to BMA 7-2

Bank Areas A through G were further evaluated to determine whether they should be carried forward as Segments 6 and 7 BMAs. The evaluation of these bank areas considered TEQ index percentage and proximity to existing BMAs presented in the Segments 6 and 7 Response Proposal.

## 3 Results of the Segments 6 and 7 Bank Areas Evaluation

The components of each evaluation criteria for Areas A through G are provided in Table 1. Based on the evaluation, Table 1 also provides the recommendation as to whether or not each area should be carried forward as a Segment 6 or Segment 7 BMA. Areas that have a lower TEQ index percentile (i.e. higher TEQ level) and are adjacent to existing Segments 6 and 7 BMAs were considered as additions to the existing BMAs. A summary of the evaluation for each area is presented below, and a map of the proposed revised Segments 6 and 7 BMAs and associated revised BMA numbers are provided in Figures 3 and 4.

- **Areas Not Recommended As BMAs**
  - **Area A:** This area has an intermediate TEQ index of 70-72%, and is not adjacent to an existing BMA. It is not recommended that this area be added as a BMA.
  - **Area B:** This area has an intermediate TEQ index of 74%. It is not recommended that this area be added as a BMA.
  - **Area D:** This area has an intermediate TEQ index of 74%, and is not adjacent to an existing BMA. It is not recommended that this area be added as a BMA.

- **Area F:** This area has an intermediate TEQ index of 72%, and is immediately downstream of BMA 7-1. It is not recommended that this area be added as a BMA.
- **Area G:** This area has an intermediate TEQ index of 60-71% and is immediately downstream of BMA 7-2. It is recommended that the bank conditions of Area G be further evaluated during the design of BMA 7-2. Findings from this evaluation will be used to determine if Area G should be included as part of this BMA.
- **Areas Recommended As BMAs**
  - **Area C:** This area has an intermediate TEQ index of 57-72%, and is not adjacent to an existing BMA. To further evaluate this area, additional bank cores were collected, which resulted in a TEQ index of 46-66%. It is recommended that the upper 450 ft of this area (TEQ index 46-53%) be added as a BMA and be named BMA 6-2 (Figure 3).
  - **Area E:** This area has an intermediate TEQ index of 56% and is not adjacent to an existing BMA. To further evaluate this area, additional bank cores were collected, which resulted in a TEQ index of 52%. It is recommended that this area be added as a BMA and be named BMA 6-4 (Figure 3).

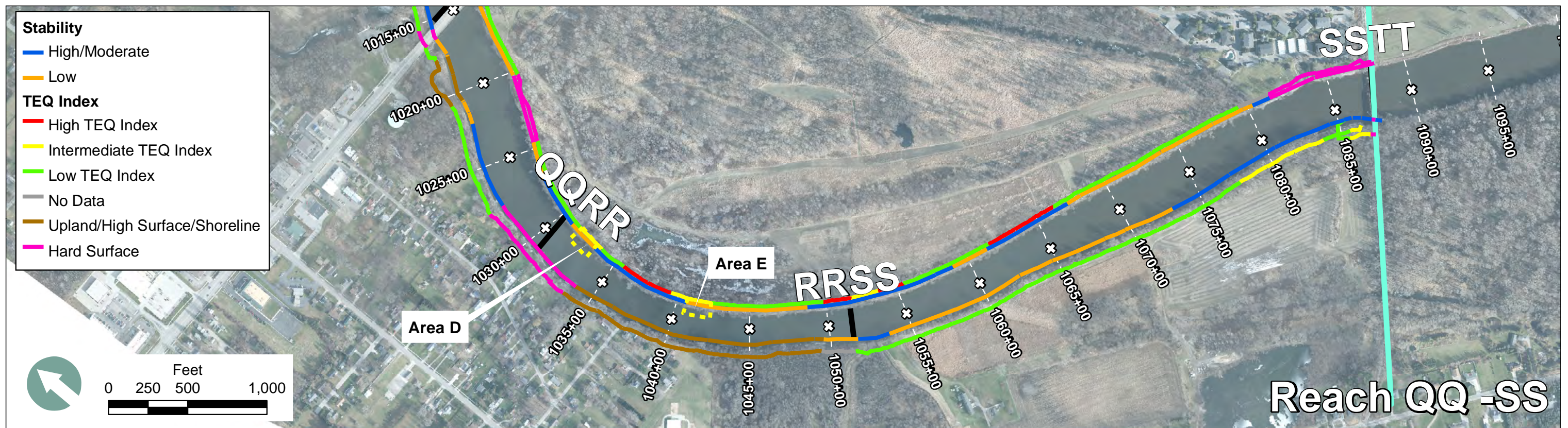
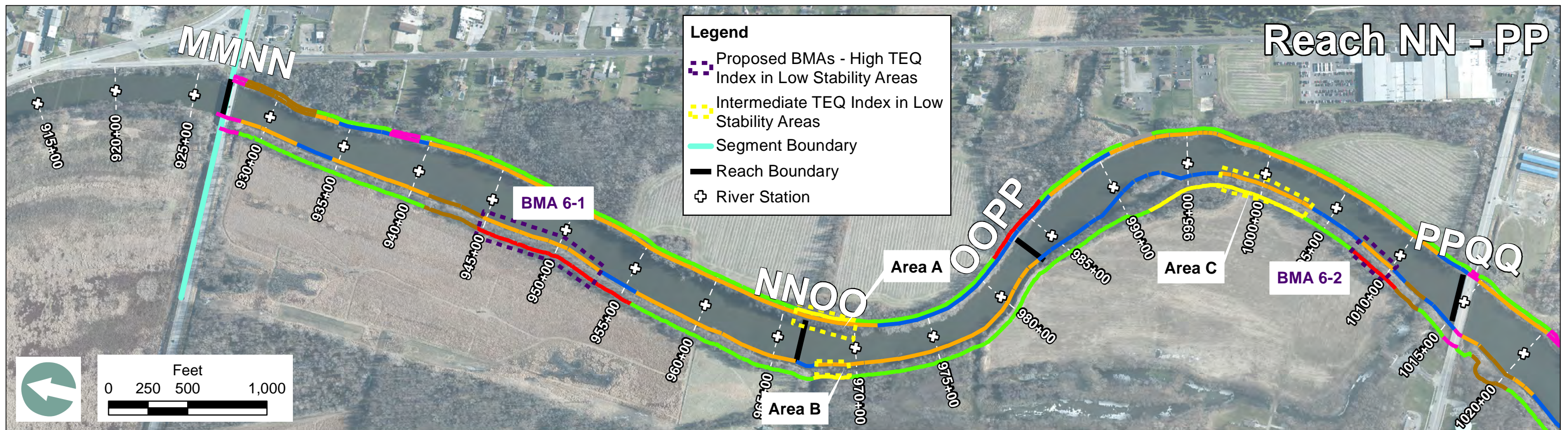
The proposed revised Segment 6 and Segment 7 BMAs are shown in Figure 3 and 4, respectively, and additional information regarding each BMA is provided in Table 2. The total length of BMAs after the extension of existing BMAs and the addition of a new BMA is 0.3 miles and 0.2 miles in Segment 6 and Segment 7, respectively. The boundaries of the Segments 6 and 7 BMAs are subject to minor changes based on additional information gathered during design.

## 4 References

Dow. 2018. Tittabawassee River Segments 6 and 7 (OU1) Response Proposal. Prepared by the Tittabawassee/Saginaw River Team. April 13. Dow Submittal Number 2018.013

## Figures



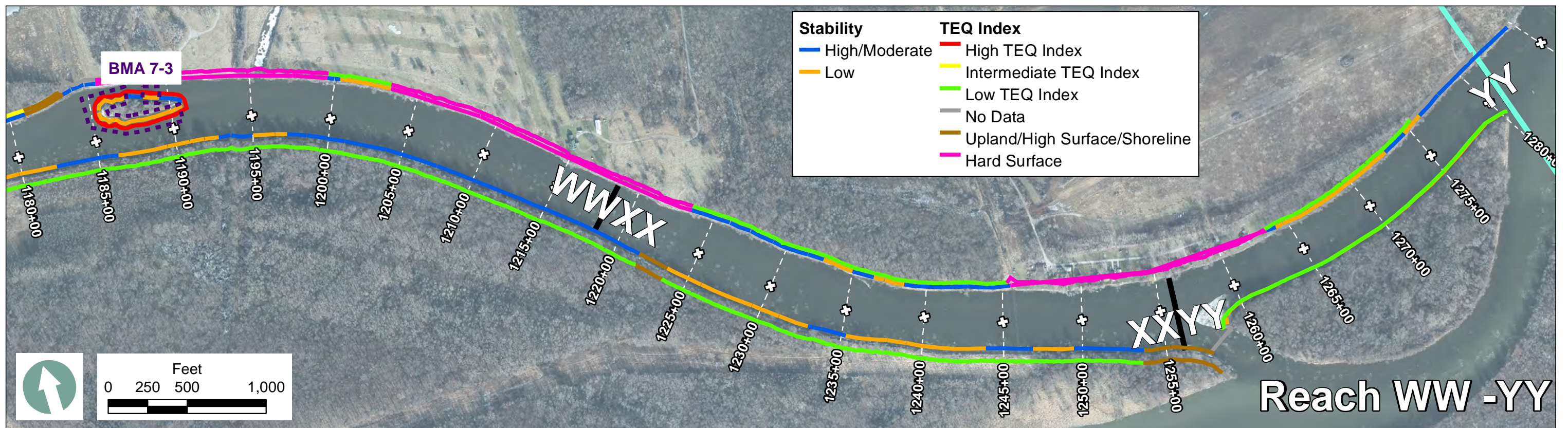
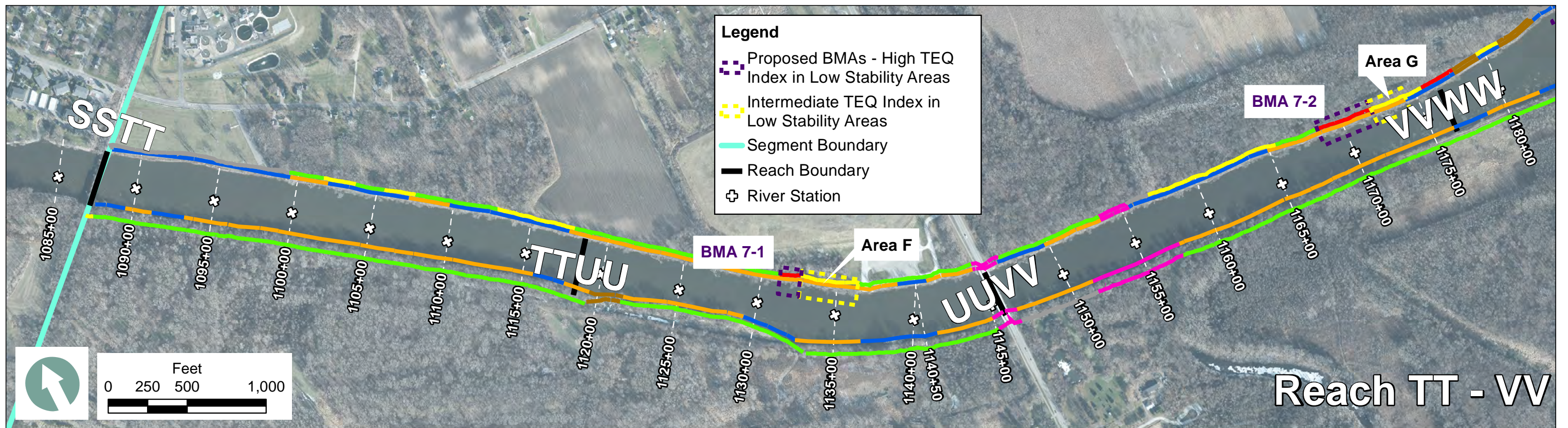


Notes:  
Aerial Imagery - 2014

Segment 6 BMAs and Areas of Interest  
Tittabawassee River Segments 6 and 7 Bank Management Area Memorandum

Figure  
1



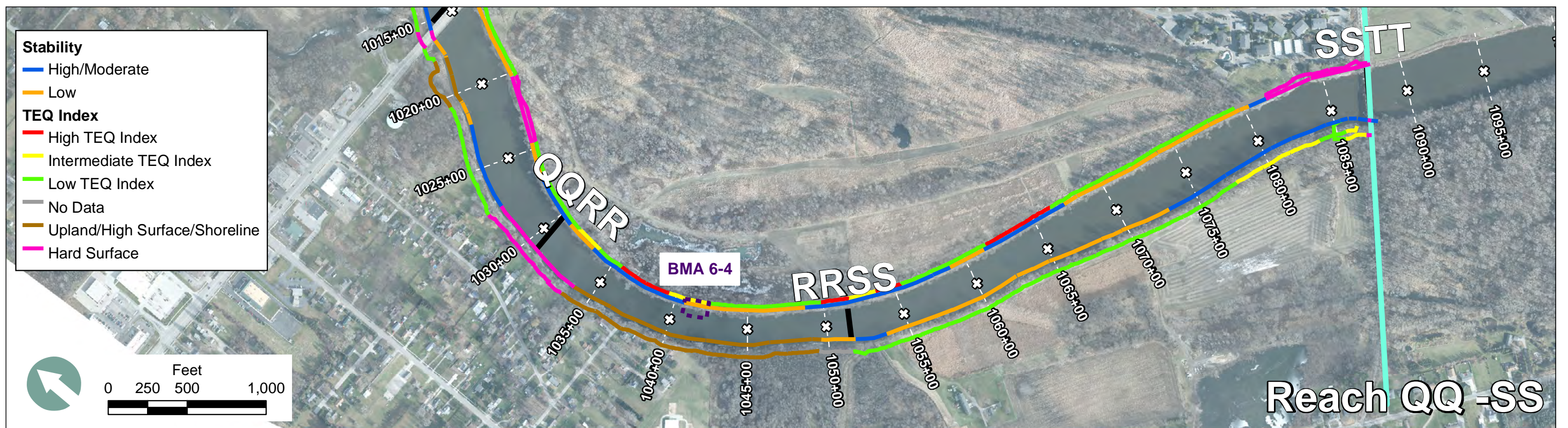
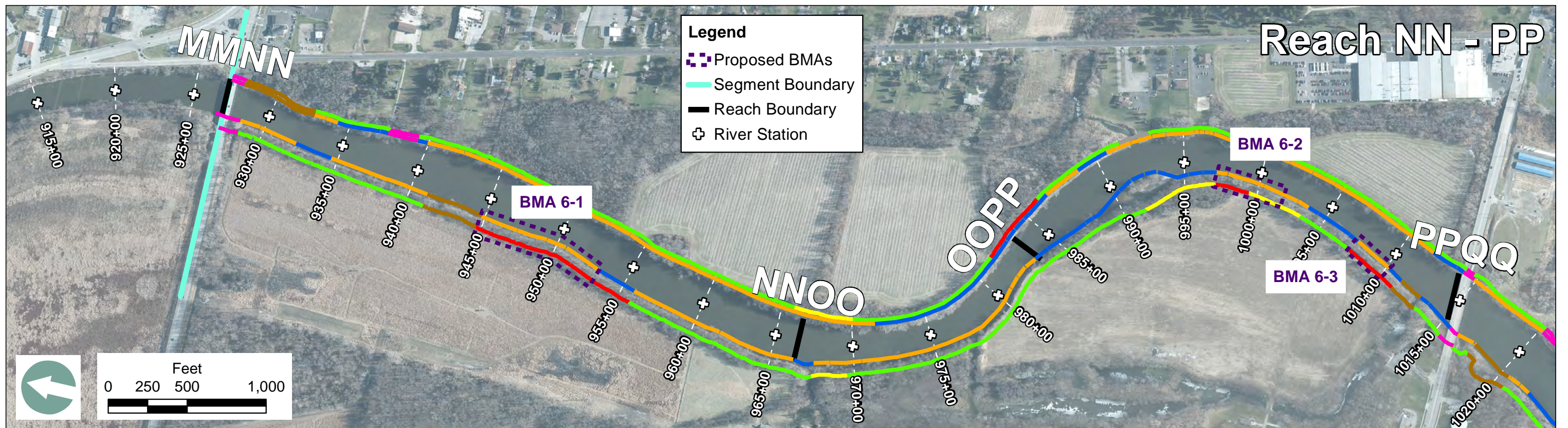


Notes:  
Aerial Imagery - 2014

Segment 7 BMAs and Areas of Interest  
Tittabawassee River Segments 6 and 7 Bank Management Area Memorandum

Figure  
2



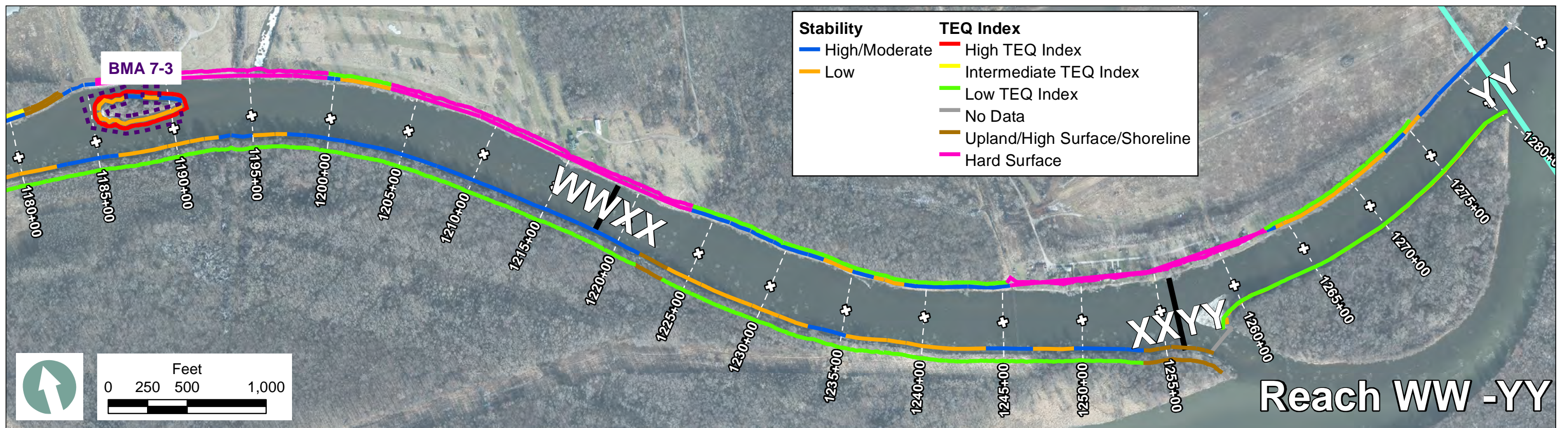
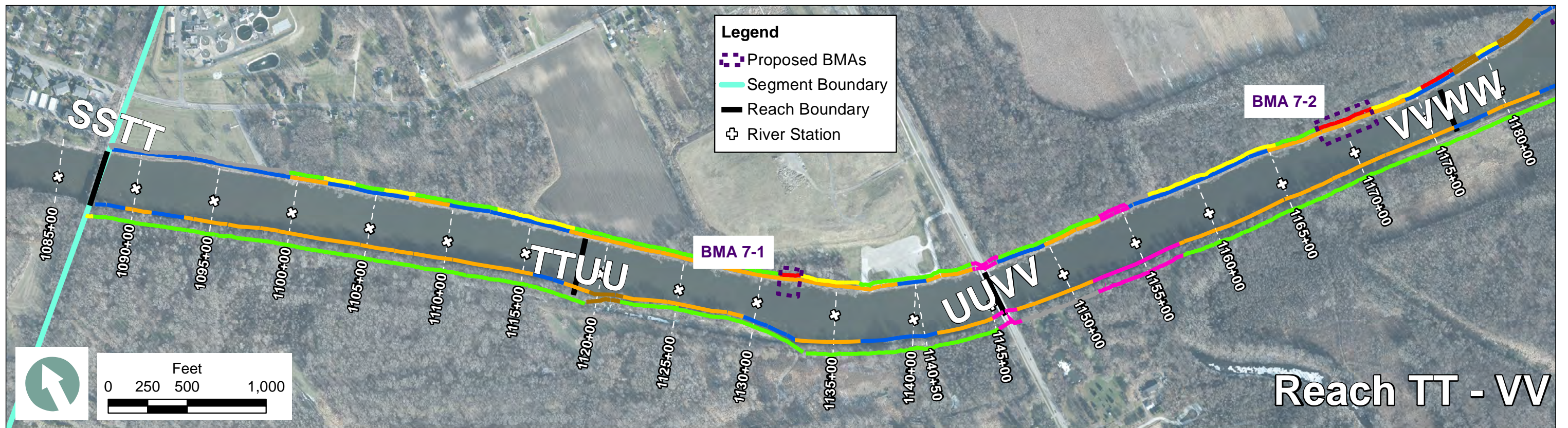


Notes:  
Aerial Imagery - 2014

Revised Segment 6 BMAs  
Tittabawassee River Segments 6 and 7 Bank Management Area Memorandum

Figure  
3





Notes:  
Aerial Imagery - 2014

Revised Segment 7 BMAs  
Tittabawassee River Segments 6 and 7 Bank Management Area Memorandum

Figure  
4



**Tables**

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**Table 1**  
**Segments 6 and 7 Bank Area of Interest Evaluation**  
**Segments 6 and 7 Bank Management Area Memorandum**

Area	Segment	Location	Length, ft	Intermediate TEQ Index	Adjacent to Existing BMA?	Recommendation
A	6	Bank: NE	390	70%-72%	No	No further action
		Reach NN/OO				
B	6	Bank: SW	210	74%	No	No further action
		Reach OO				
C	6	Bank: SW	600	46%-66%	No	Add upstream 450 ft as BMA
		Reach PP				
D	6	Bank: NE	150	74%	No	No further action
		Reach RR				
E	6	Bank: NE	160	52%	No	Add as BMA
		Reach RR				
F	7	Bank: NE	360	72%	Yes, immediately downstream of BMA 7-1.	No further action
		Reach UU				
G	7	Bank: NE	220	60%-71%	Yes, immediately downstream of BMA 7-2.	Evaluate during design
		Reach VV				

**Table 2**  
**Revised Segments 6 and 7 BMAs**  
**Segments 6 and 7 Bank Management Area Memorandum**

BMA	Reach	Side of River	Length, ft	Number of Property Owners	Property Type
6-1	NN	SW	830	1	Private
6-2	PP	SW	450	1	Public
6-3	PP	SW	270	1	Public
6-4	RR	NE	160	1	Private
7-1	UU	NE	130	1	Public
7-2	VV	NE	360	1	Private
7-3	WW	Island	815	Not applicable	Not applicable